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AUTHOR Siemankowski, Francis T.
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ABSTRACT

Although educational research has produced an abundance of useful findings, the quality of education has improved but very little. In spite of an ever-increasing financial outlay at all governmental levels, schools are falling short of expectations of those who must use the products of public education. The answer to, "Why can't the schools improve the product?" will not be found through use of industrial concepts, but by a better understanding of the learning process. The effectiveness of Skinner's learning psychology as applied in the Auto-Paced Teaching Process (APT) as compared to conventional instruction is tested. The sample included 132 college science students: 44 in APT group; 88 in the conventionally taught control group. Subjects were randomly assigned to groups. Treatment variable tested was the effect of Skinner's contingencies of reinforcement employed in instruction of the APT group. Criterion tests included achievement tests, Purdue Attitude, STEP-Listening, Welch Science Process Inventory, and Science Unit Rating Scale. ANCVA of achievement test scores show APT significantly higher at .025 level in 2 of the 3 science topics studied. Covariate analysis of attitude scores significantly favor APT students at .001 level. APT students took 28% less time to complete assigned tasks. Results indicate that application of clinically tested learning theories to classroom instruction will produce greater teaching efficiency. (Author/PR)

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Applying Skinner's Contingencies of Reinforcement in Auto-Paced Learning Laboratories

(Paper Presented by F.T. Sienankowski, AERA, Feb. 7, 1971)

Although educational research has produced an abundance of findings, the quality of education in our schools has improved very little. Promises of "better schools for better communities" have not materialized. In spite of an ever-increasing financial outlay at the federal, state and local levels schools are falling short of the expectations of those who must use the products of public education. After listening to the continuous pleas of educators for research funds, higher teacher salaries, employment of qualified specialists, reduction of class size, introduction of special equipment, and huge capital investments parents, taxpayers and legistlators--those who provide the money--find that schools have little to show to justify these increased expenditures. Obviously, more money is not the answer.

The case against traditional public instruction is overwhelming. Penney, et al. (1970) report that during the past eleven years, the U.S. Office of Education invested $12 million in support of reading research, yet reading instruction is at a plateau.

The recent release of the Survival Literacy Study by the presidentially appointed National Reading Council has some surprising statistics. A survey conducted at the council's request by Louis Harris and Associates, Incorporated shows that 7% of all Americans have difficulty filling out an application for a Social Security number. Eleven per cent need help filling out a personal bank loan. Thirty-four per cent cannot fill-out the Medicaid application. The report states that 4.3 million Americans are considered functionally illiterate.

Kilpatrick (1970) reporting a Senate committee hearing held last May in Washington, D.C. describes the testimony of Neil Sullivan, former superintendent of schools in Berkeley, California. Sullivan stated,

"We went the whole route, lowered class size, provided remedial reading teachers, bought the machines, did those things we thought were right. The results after two and a half or three years clearly indicate that not only did the child in the inner city not improve, he had retrogressed."

The problem is not confined to deficiencies in the basic skills of reading, mathematics and writing. The obsolescence of current teaching practices cuts across all levels of instruction--from that of early elementary to the post-doctoral programs. The universal dissatisfaction expressed by both the recipients of education and those who must pay the bills must be faced squarely if public education is to survive.

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What has been the response of educators and planners to these charges? Some feel the industrial analogy is valid, thus we now have

added to the educational paradigm such terms as accountability, guaranteed performance contracts, systems analysis, tuition vouchers, out-put oriented management, the pupil-change model school, consumer-choice education, and countless other expressions recently generated.

Industry is making a great effort to break the monopoly public schools have on American education. Through industry-oriented spokesmen in the education community the following arguments are being used:

1. A greater variety of instructional methods could be tested by free market methods if parents were given a choice in the type of school to which they could send their children.

2. The price paid for instruction should be commensurate with the gains made by students during a given time period.

It is difficult to find fault with their two postulates. The advocates of the industrial approach to the solution of our educational problems have gained supporters. Yet, one can readily see that this approach is only a modification of patterns followed by educators in the past in their efforts to find a "better way." Here, the industrial analogy can be drawn again. Educators, like automobile manufacturers, feel it's necessary to find a new line or a new model every four or five years in order to stay in business.

This policy of drift from one educational plan to another will not solve the problem confronting us. These remedies do little more than divert attention from the real problem. What is at the base of the problem is the complexity of the learning process. It is evident there is an urgent need for a unified science of learning.

Psychologists have investigated learning theory in the laboratory and have made impressive advances towards the understanding of the learning process. Many psychologists are of the opinion that a science of learning based on knowledge gained in the laboratory is still in the distant future. Hilgard(1956) states, "There are no laws of learning that can be taught with confidence.: By contrast, Skinner and his associates feel that they have discovered a number of useful learning principles in the laboratory that are applicable to public education.

Skinner's learning psychology emphasizes an active response on the part of the learner followed by a reinforcer(or reward) if the response is the one desired by the instructor. Skinner's application of this principle to classroom instruction was in the form of programmed textbooks and teaching machines. These efforts were met with substantial opposition from the educational community. It should be noted however, that programmed texts and teaching machines are not the only way to apply Skinner's principles of learning. The limits of application of his principles rest only on the imagination of the user.

An investigation conducted at State University College, Buffalo, New York tested the effectiveness of Skinner's learning psychology as applied to the auto-paced learning laboratory. The teaching technique tested, the Auto-Paced Teaching Process(APT Process) relies heavily on Skinner's principle of reinforcement of correct responses.

Objectives of the Inquiry

The hypothesis tested the superiority of the Auto-Paced Process, a Skinner-oriented learning process, when compared to conventional instructions in terms of 1) achievement in physical science, 2) attitudes towards science, 3) understanding the processes of science, 4) ability to prepare science unit plans, and 5) time required to complete course assignments.

Methods and Techniques

Six sections of a multi-section course in physical science were selected as the research sample. These sections were taught by two instructors. One section from each instructor was randomly selected and placed into the Auto-Paced Teaching Process treatment. The remaining sections formed the control group. There were 44 subjects in the treatment group and 88 in the control group.

To check the homogeneity of the treatment and control groups, Bartlett's test for homogeneity of variance was performed. Test results showed both groups to be similar. A further test using STEP-Listening 1A test instrument produced evidence that both groups were nearly identical in composition, and typical of the U.S. college population.

The treatment of both groups was identical as to course content, visual aids, and laboratory exercises performed. The treatment variable tested was the effect of Skinner's contingencies of reinforcement (Skinner, 1965) employed in the instruction of the APT group. Contingencies of reinforcement, as used in this study, refers to feedback given APT students after a response was made. The feedback included the correct response, and why it was correct.

The APT students used programmed textbooks for home study. Their laboratory exercises were audio-tape directed. Both, the textbook and tapes, provided reinforcement of correct response at each step of the learning process.

Data Sources

Test instruments used included locally validated achievement tests, the Purdue Master Attitude Scales, STEP-Listening 1A, Welch Science Process Inventory, and the Science Unit Rating Scale*.

Results and Conclusions

Analysis of variance of posttest scores(TABLE 1) show the auto-paced group's scores significantly higher than those of the conventional group in the geology and astronomy units. No significant difference was found in the meteorology unit.

Covariate analysis of the Purdue attitude scores show the APT group significantly higher at the .001 level of confidence. The findings indicate that conventional teaching methods used in the study had no effect on student attitudes towards science. By contrast, APT methods produced a strongly favorable change in the attitudes.

*Science Unit Rating Scale, designed and validated by F.T.Siemankowski in 1968 for use in research only.

TABLE 1

SUMMARY OF ANALYSIS OF VARIANCE
OF ACHIEVEMENT SCORES

Unit	Total df	MS_B	MS_W	F Ratio	Null Hypothesis
Geology	134	258.13	44.68	5.78*	Reject
Astronomy	131	387.88	23.61	16.48**	Reject
Meteorology	131	43.37	18.74	2.31	Fail to Reject

* Significant at .025
** Significant at .001

Covariate analysis of the Welch SPI scores show no significant difference in the means of the two groups at the .05 level, however, the mean of the auto-paced group was higher. These findings indicate that a teaching method alone cannot significantly influence a student's understanding of the processes employed by scientists in their search for new knowledge.

To test the planning ability, three jurors were selected to rate the science unit plans submitted by students in both groups. The jurors, having no knowledge of the source of the science units, and working independently of each other, rated the unit plans of the auto-paced group higher than the units submitted by the conventionally taught group. The ratings were significantly higher at the .05 level in 5 of the 30 F tests performed on the 10 subscales included in the Science Unit Rating Scale.

The conventionally taught students required 28 per cent more time than the APT students to complete the same task. Time study findings are indicative of the greater efficiency of the APT Process.

Findings related to the main hypothesis show that there was a significant correlation at the .001 level between learning potential as measured by STEP scores and quality points earned by the auto-pace students. This was not true of the conventional group.

When groups were divided into ability sublevels, the auto-paced method challenged high achievement at all levels. The Q_1 group over-achieved. By contrast, conventional methods proved satisfactory only for the Q_1 group.

A negative correlation between STEP scores and achievement scores of the upper level subgroup of the conventionally taught students indicates that these methods are not reaching the superior nonscience student.

Educational Importance of Study

The study does point-up the possibility for more efficient teaching developing from the application of learning theories tested in psychological laboratories. Structuring the teaching process upon findings related to the functioning of the mind is more likely to produce a unified science of learning than the process of drift now

so prevalent in education. Rather than emulating industrial techniques, educators should profit from fellow professionals in the medical field and treat the cause of the problem and not its symptoms.

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